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ABSTRACT

Since the measurement of school achievement involves the administration of achievement tests to various grades on various subjects, both grade level and subject matter contribute to within-school achievement variations. To determine whether achievement test scores vary most among different fields within a grade level, or within fields among different grades, achievement test scores from 88 Israeli elementary schools were examined. Test scores of the resulting 15 combinations of grades by subjects were averaged. The average within-school variance was 25% of the total across-schools variance, showing notable heterogeneity. Computation of the within-school range for the 15 means showed 55% to exceed one standard deviation. Further analyses showed more similarity in mean achievements of the same grade level in different fields than of different grade levels in the same field. The first analysis, involving a within-school anlaysis, had three components: between grades, between subject areas, and the interaction. The second, nonmetric analysis of the correlation matrix between the 15 school means was conducted using smallest space analysis and ADDTREE. Furthermore, in 88% of the schools where over 51% of the within-school variance was caused by a single component, that component was grade level. (MGD)

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THE HOMOGENEITY OF SCHOOL ACHIEVEMENT

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The last 20 years witnessed an ever increasing awareness of the "unit of analysis" problem in general, and of the school, as the appropriate object of inquiry in educational research, in particular. The smallest autonomous unit in most educational systems, the school is also the smallest unit for many policy-making decisions.

Among the various school characteristics, school achievement is the most prominent. Since instruction is usually organized according to grade level and subject matter, the measurement of school achievement involves the administration of a different achievement test for each combination of grade and subject matter. Corresponding to each test there is a school mean score. Therefore, a proper conceptualization of school achievement involves the set or profile of the grade by subject matter school means. Obviously, the raw mean test scores of the same school on different tests are not directly comparable. However, ipsative comparisons are possible between the z-scores corresponding to the various school means in the relevant population of schools.

A relevant question concerning school achievement profiles refers to their heterogeneity or scatter. To what extent are schools homogeneous in terms of achievement? In addition to its intrinsic significance, this question also has practical implications for policy decisions. For example, noticeable heterogeneity of school achievement profiles may raise doubt concerning the status of schools as the smallest units for the differential allocation of resources.

A related question concerns the relative contributions of grade level and subject matter to the within school variation in achievement. Put

differently, the question is which is usually higher: the within grade level variation of the school means in different fields or the within field variation of the school means for different grade levels?

The study reported here was concerned with the empirical investigation of these two questions. The sample consisted of grades 1,2,4 and 6 in 98 elementary schools in a large scale study of the Israeli elementary education (Minkowich, Davis & Bashi, 1982), in which students were administered several achievement tests. The grade level by subject matter test matrix is presented in Table 1.

Table 1 about here

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88 schools had complete information. Test scores for each of the 15 combinations of grade by subject matter were averaged for each of these schools. Each of the 15 means was standardized in the entire sample of schools with mean zero and unit standard deviation.

RESULTS

One definition of the heterogeneity of school achievement profiles is in terms of the within school variance of the 15 standardized means. This was computed for each of the 88 schools. The average within school variance was found to be 25% of the total, across schools variance, with a standard deviation of 18%. This is interpreted as evidence for the noticeable heterogeneity of the achievement profiles of a considerable proportion of

schools. Another way to illustrate this heterogeneity is by means of the within school range of the 15 standardized means (see Table 2).

Table 2 about here

In 55% of the schools, this range exceeded one standard deviation.

I turn now to the second question. Given that school achievement varies considerably between the different combinations of grade level and subject matter, which are more similar: the relative achievements of the same school for different grade levels in the same subject matter or the relative achievements of the same grade level in different subject matters? Two analyses, which are based on the same data, were performed:

1) A within schools analysis, involving the decomposition of the within school variance of the 15 grade by subject matter means into three components: between grades, between subject matters, and the interaction between grade and subject matter.

2) An overall nonmetric analysis of the correlation matrix between the 15 schools means in the sample of 88 schools. This was done by two methods: Smallest Space Analysis (SSA, Guttman, 1968) and ADDTREE (Sattath & Tversky, 1977).

Both analyses revealed the same phenomenon: the mean achievements of the same grade level in different fields were considerably more similar than the mean achievements of different grade levels in the same field. In within school terms this is reflected in the fact that on the average across schools, only 23% of the within school variance lies between subject

matters, vs. 44% between grade levels (see Table 3). A related, perhaps even more impressive finding is that in 88% of the 44 schools in which at least 51% of the within school variance was attributable to a single component, this component was grade level, rather than subject matter.

Table 3 about here

From an overall, across schools point of view the same phenomenon is reflected in correlations which are higher, on the average, between subject matters, within the same grade level, than within subject matter, between grade levels. The correlation matrix among the 15 school means is given in Table 4.

Table 4 about here

Guttman and Lingoes' SSA-I (see Figure 1) and Sattath and Tversky's ADDTREE (see Figure 2) provide two different representations of the correlation matrix. Both illustrate the greater similarity between the relative achievements of the same grade level in different fields than between the relative achievements of different grade levels in the same field.

Figure 1 and 2 about here

A practical implication of these findings concerns the sampling of grade levels and subject matter for the purpose of estimating the elevation of the school achievement profiles, usually defined in terms of the average of the grade by subject matter means. They point to sampling of grade levels rather than subject matters as the preferred approach to the estimation of the overall index of school achievement. However, these findings may be highly specific to the educational system, grade levels, and subject matters investigated. Extensive research is needed to determine generalizability over these dimensions.

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Guttman, L.A. (1968) A general nonmetric technique for finding the smallest coordinate space for a configuration of points. Psychometrica, 33, 469-506.

Minkowich, A., Davis, D. & Bashi, J. (1982) Success and Failure in Israeli Elementary Education. New Brunswick: Transaction Books.

Sattath, S. & Tversky, A. (1977) Additive similarity trees. Psychometrica, 42, 319-345.

Table 1: The grade level x subject matter test matrix.

Grade Level	Reading* Comprehension I	Reading* Comprehension II	Math	Geography	Science
1	L1	R1	M1	-	-
2	-	R2	M2	-	-
4	L4	R4	M4	J4	T4
6	L6	R6	M6	J6	T6

* L and R are two different Reading Comprehension tests.

Table 2: The within-school range of the 15 standardized school means.

The within-school range*	Percentage of schools
0 - .5	23
.5-1.0	21
1.0-1.5	30
1.5-2.0	12
2.0-2.5	5
2.5-6.0	9
Total	100

* Standard deviation units.

Table 3: The distribution (percentages of schools) of the between-grade levels, between subject matters and residual components of the within school variance.

Proportion of within school variance	Between grades	Between subject matters	Residual (Interaction)
0-.25	27	68	35
.26-.50	39	26	49
.51-.75	25	6	16
.76-1.0	9	-	-
Total	100	100	100
Mean	.44	.23	.33
S.D.	.23	.15	.18

Table 4: The correlations between the 15 grade by subject matter school means.

			Grade 1			Grade 2		Grade 4					Grade 6			
Grade	Test	Symbol	L1	M1	R1	M2	R2	J4	L4	M4	R4	T4	J6	L6	M6	R6
1	Math	M1	.71	-												
	Reading Comprehension	R1	.88	.76	-											
2	Math	M2	.57	.73	.64	-										
	Reading Comprehension	R2	.62	.72	.70	.85	-									
4	Geography	J4	.55	.65	.55	.65	.78	-								
	Reading Comprehension	L4	.65	.74	.69	.76	.84	.82	-							
	Math	M4	.57	.65	.65	.73	.83	.82	.89	-						
	Reading Comprehension	R4	.61	.74	.66	.73	.82	.81	.89	.87	-					
	Nature	T4	.48	.65	.55	.73	.80	.78	.85	.85	.78	-				
6	Geography	J6	.51	.62	.54	.68	.76	.74	.82	.77	.75	.79	-			
	Reading Comprehension	L6	.60	.68	.62	.75	.80	.75	.89	.79	.80	.78	.91	-		
	Math	M6	.57	.62	.58	.68	.75	.74	.82	.80	.77	.74	.89	.90	-	
	Reading Comprehension	R6	.57	.68	.60	.72	.79	.72	.84	.74	.76	.77	.89	.91	.87	-
	Nature	T6	.47	.60	.52	.69	.75	.72	.80	.79	.74	.79	.85	.84	.84	.77

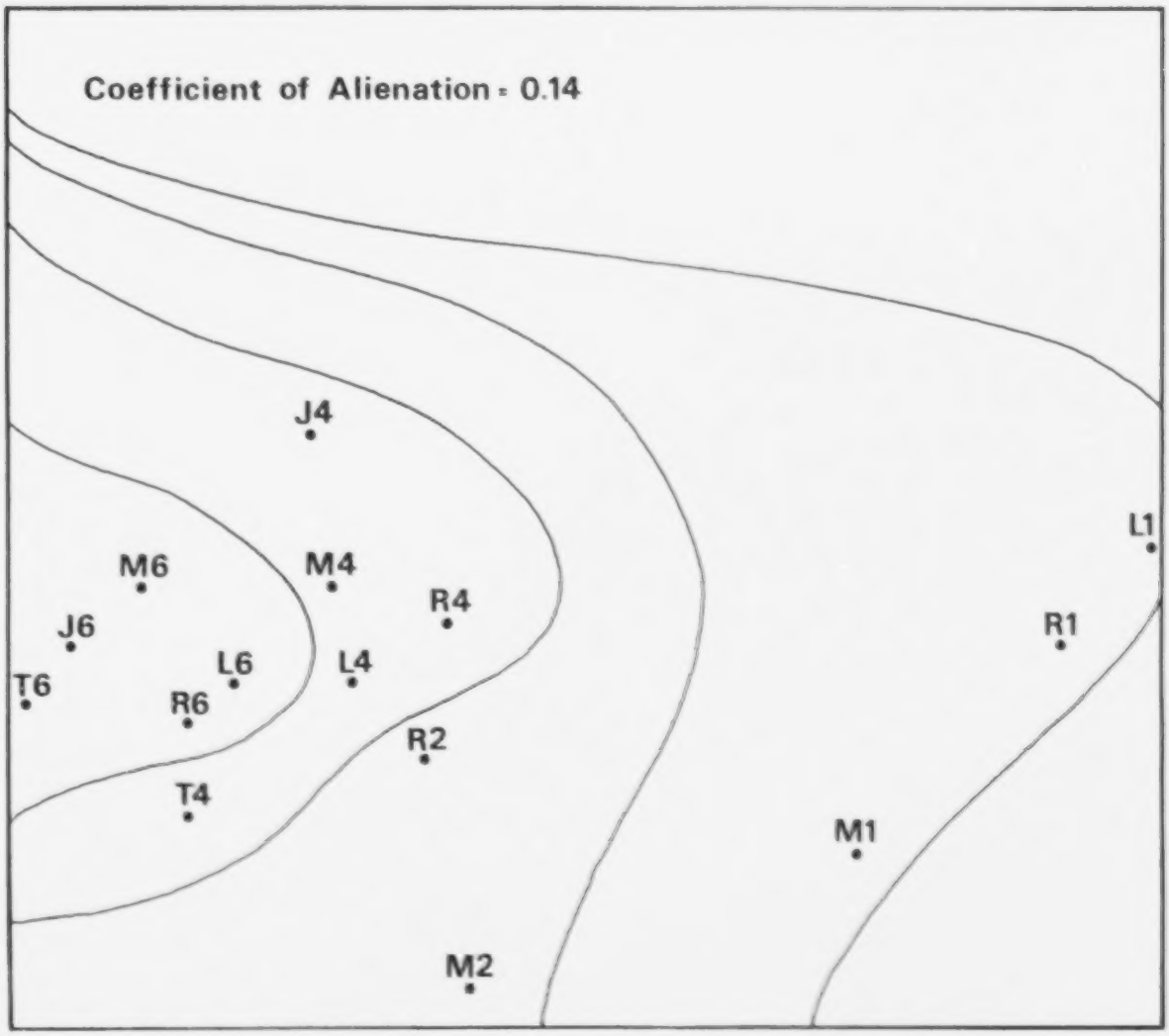

Figure 1: The smallest space analysis (SSA-I) of the similarity relations among the 15 grade by subject matter school means.

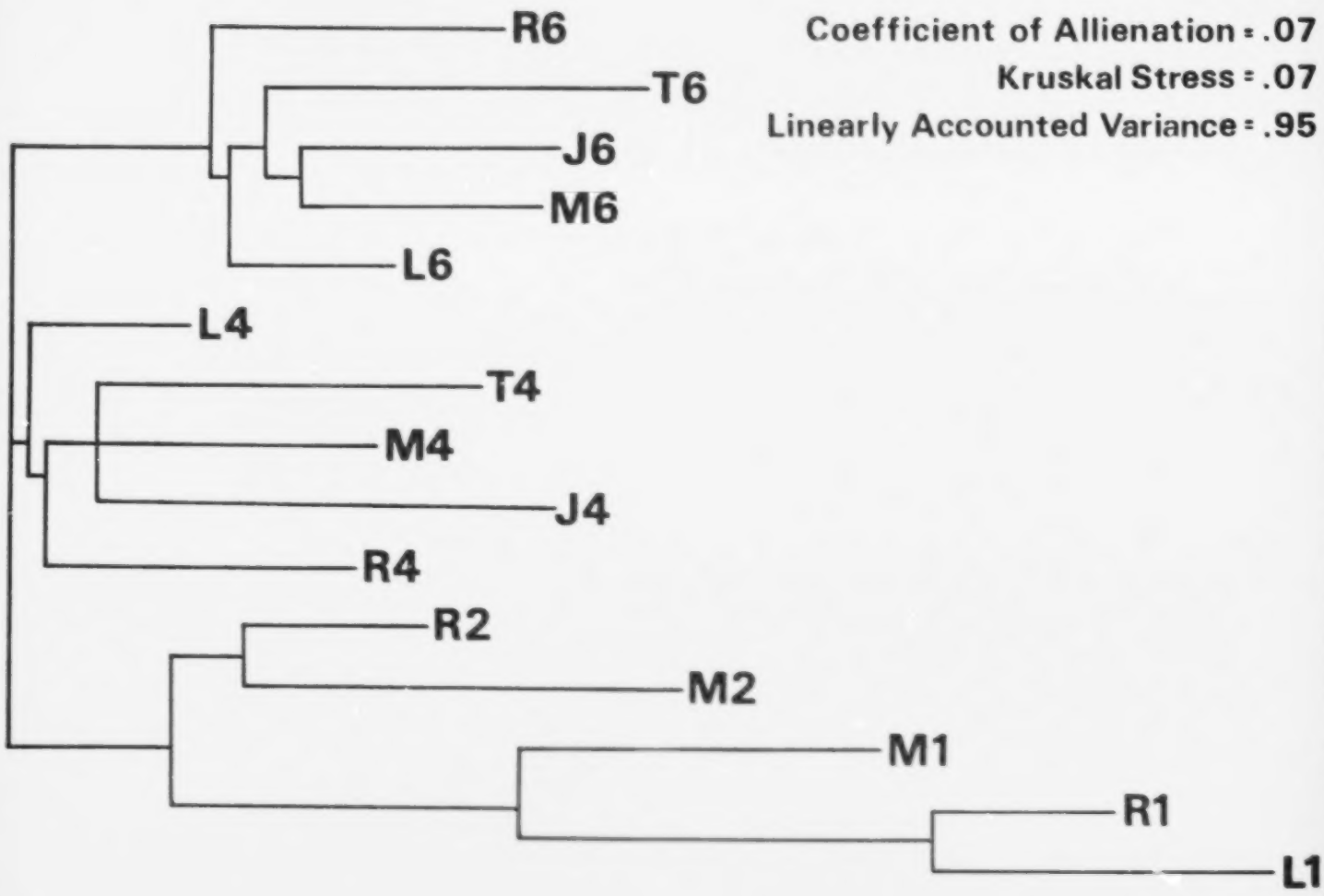

Figure 2: The Additive Tree (ADDTREE) representation of the similarity relations among the 15 grade by subject matter school means.